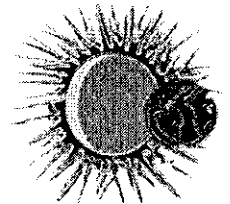


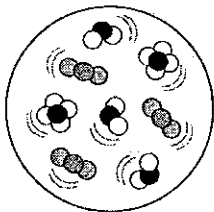
# The Greenhouse Effect

## The Sun

Life on planet Earth relies on the sun - a star - that is 93 million miles away. Without the sun's heat and light, Earth would be a lifeless and icy ball of rock. Solar energy from the sun warms our air and seas, generates weather patterns, and provides energy to photosynthetic plants. When this energy reaches Earth, some of it is reflected and some of it is absorbed by the Earth's surface. When Earth absorbs the sun's energy, Earth's surface heats up. Some of the energy that Earth absorbs is emitted as infrared radiation, a type of radiant energy on the electromagnetic spectrum that our eyes cannot see.



## The Greenhouse Effect



Earth's atmosphere, the envelope of gases around Earth, is naturally made of different gases, mostly nitrogen ( $N_2$  78%) and oxygen ( $O_2$  21%). Other gases, like carbon dioxide and methane, are called greenhouse gases. Greenhouse gases are larger molecules that can absorb infrared radiation. When greenhouse gases absorb infrared radiation, they vibrate, causing the air around them to warm, much like your body gains heat when you shiver. These molecules then release infrared radiation, which causes more molecules to vibrate, ultimately warming the atmosphere. The more greenhouse gases there are, the warmer the atmosphere can get. This process is known as the greenhouse effect because, like the glass in a greenhouse, Earth's atmosphere traps some heat instead of letting it escape into space.

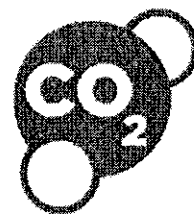
All life on Earth depends on this greenhouse effect. At normal levels, greenhouse gases are necessary for life because they trap heat and keep Earth at the perfect temperature for living things. Having fewer greenhouse gases in the atmosphere would make Earth too cold. However, human activities and man-made processes have added extra greenhouse gases to the atmosphere so more heat is trapped and the greenhouse effect is exaggerated.

## Greenhouse Gases

There are several greenhouse gases in Earth's atmosphere. They occur at different levels and have differing effects on atmospheric temperatures. Read more about each below:

- **Water vapor ( $H_2O$ ):** At up to 4% of the atmosphere, water vapor is the most abundant greenhouse gas in the atmosphere. Through natural processes, water continually evaporates from rivers, oceans, and other sources to become water vapor, water's gas phase. The warmer air is, the more water it can hold. This means that if the Earth's temperatures get warmer, the amount of water vapor in the atmosphere will increase. This increase in a greenhouse gas will then warm the planet even more.

• **Carbon Dioxide (CO<sub>2</sub>):** The greenhouse gas contributing the most to climate change is carbon dioxide. Carbon dioxide is a colorless gas that is added to the atmosphere naturally. This happens when organisms respire or decompose, when carbonate rocks are weathered, forest fires occur, and volcanoes erupt. Long before human activity, CO<sub>2</sub> was balanced by the carbon cycle, a series of processes that cycle carbon through the atmosphere and living and non-living things. Extra CO<sub>2</sub> enters the atmosphere when fossil fuels such as natural gas, oil, and coal are burned for electricity and transportation. Fossil fuels were formed from the remains of ancient plants and animals and are found deep in the Earth's crust. Before humans, the carbon contained in fossil fuels would have stayed underground forever. Extracting and burning fossil fuels increases CO<sub>2</sub> in the atmosphere and causes an increase in the greenhouse effect. In fact, evidence shows that Earth's average temperature has been increasing right along with the increasing CO<sub>2</sub> levels from burning fossil fuels. Today, Earth's atmosphere contains about 0.4% carbon dioxide.



• **Methane (CH<sub>4</sub>):** Methane is a colorless and odorless gas. One molecule of methane contains one atom of carbon and four molecules of hydrogen. Methane naturally enters the atmosphere from decay (rot and decomposition) that happens in wetlands and marshes. However, far more



methane enters the atmosphere as a result of human activities as a result of livestock flatulence (yes, farts) and by the breakdown of waste in landfills. Methane also enters the atmosphere from leaks during the production of fossil fuel products such as coal, natural gas, and oil. At just 0.00017% of the atmosphere, methane levels are lower than CO<sub>2</sub> levels but still concern scientists because methane absorbs heat much better than carbon dioxide does.

• **Chlorofluorocarbons:** CFCs are a group of compounds that contain the elements chlorine (Cl), fluorine (F), and carbon (C). At room temperature, they are colorless liquids that evaporate easily. They have no natural source but have entered the atmosphere from chemical refrigerants, aerosol propellants, and cleaning solvents.



• **Other Greenhouse Gases:** Nitrous oxide (N<sub>2</sub>O) is a greenhouse gas that is a natural part of the nitrogen cycle but also produced by industrial processes. Another greenhouse gas, low level ozone (O<sub>3</sub>), is a result of air pollution.

### Summary

At normal levels, greenhouse gases are necessary for life on Earth. However small changes in their levels can affect our climate. The quantity of greenhouse gases is increasing as fossil fuels are burned and through other man-made sources. With more greenhouse gases in the air, more heat is trapped in the atmosphere, warming the planet. In an effort to halt an increase in the greenhouse effect, people are looking for ways to reduce greenhouse gas emissions by using alternative energy sources and creating laws that control polluting emissions.

# The Greenhouse Effect

Name \_\_\_\_\_

Directions: Read the article *The Greenhouse Effect* and answer the questions below.

1. Use context clues from the text to define the following terms:

Lifeless – \_\_\_\_\_

Infrared radiation – \_\_\_\_\_

Atmosphere – \_\_\_\_\_

Greenhouse gases – \_\_\_\_\_

Greenhouse effect – \_\_\_\_\_

Abundant – \_\_\_\_\_

Evaporate – \_\_\_\_\_

Decay – \_\_\_\_\_

2. Complete the grid below. Answers not found in the text are provided for you.

Gas In Atmosphere	Chemical Symbol	Where Does It Come From?	Approximate Level in the Atmosphere	Greenhouse Gas? (Y or N)
Nitrogen		Present from Earth's early atmosphere		
Oxygen		From plants performing photosynthesis		
Water Vapor				
Carbon Dioxide				
Methane				
CFCs	Different compounds containing Cl, F, C.		There are different types of CFCs in varying amounts each.	
Nitrous Oxide			0.00003%	
Ozone			0.000004%	

3. Where does infrared radiation come from?
4. Explain what happens when infrared radiation reaches Earth.
5. What property of greenhouse gases makes them important to Earth's temperatures?

#### Did You Know?

*Termites are a natural source of atmospheric methane, each producing about 1/2 a microgram of methane per day. This seems small, but when multiplied by the world population of termites, global methane emission from termites is estimated to be 20 million tons each year!*

6. What happens to greenhouse gas molecules when they encounter infrared radiation?
7. Greenhouse gases occur naturally in Earth's atmosphere.
  - a. Why are they important?
  - b. Explain why increases in greenhouse gases in the atmosphere are of concern.
8. How does the temperature of air affect how much water it can "hold"?
9. Which gas do scientists think is the most connected to climate change? What evidence supports the idea that increasing levels of this gas leads to increasing global temperatures?
10. Methane exists in the atmosphere in much lower levels than carbon dioxide. Why are scientists still concerned about it?
11. If one of your friends said "I'm going to save the planet by inventing a machine that takes all the greenhouse gases out of the air!", would you congratulate them OR would you warn them it's a bad idea? EXPLAIN your answer.